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ABSTRACT

Using eighth-grade transcript and questionnaire data from the National Education Longitudinal Study of 1988, this study used logistic regression procedures to investigate the extent to which the probability of mathematics proficiency depends on the values of various background factors. The results of the analyses, which were based on a subsample of approximately 450 students, indicate that when race and gender were the sole explanatory variables, the probability of mathematics proficiency at the highest level was greatest for Asian/Pacific Islanders and Whites. Using this model, the odds of mathematics proficiency for females were no different from that of males. When other factors were included in the model, the probability of mathematics proficiency increased with advanced math course enrollment, grades, socioeconomic status, reading proficiency level, and homework. In addition, when other factors were controlled, males were more likely to achieve at the highest level of proficiency than females. A cumulative logit model was used to assess the effect of the explanatory variables on the cumulative probabilities for math proficiency. The results of this analysis reveal that attendance at private nonreligious schools, advanced math enrollment, and increased homework increase the odds of higher mathematics proficiency. Chi-squared tests of the association between mathematics proficiency and the covariates as well as correlation analyses among the covariates suggest that the absence of some variables from the prediction equations may be a results of multicolinearity among the explanatory variables. (Author/SLD)

A Model of Mathematics Achievement using Proficiency Scores

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Abstract

Using eighth-grade transcript and questionnaire data from the National Education Longitudinal Study of 1988, the current study used logistic regression procedures to investigate the extent to which the probability of math proficiency depends on the values of various background factors. The results of the analyses indicated that when race and gender were the sole explanatory variables, the probability of math proficiency at the highest level was greatest for Asian/Pacific Islanders and Whites. Using this model, the odds of math proficiency for females were no different than for males. When other factors were included in the model, the probability of math proficiency increased with advanced math course enrollment, grades, socio-economic status, reading proficiency level, and homework. Additionally, controlling for the other factors males were more likely to achieve at the highest level of proficiency than females. A cumulative logit model was used to assess the effect of the explanatory variables on the cumulative probabilities for math proficiency. The results of this analysis revealed that attendance at private non-religious schools, advanced math enrollment, and increased homework increases the odds of higher math proficiency. Chi-squared tests of the association between math proficiency and the covariates as well as correlation analyses among the covariates suggest that the absence of some variables from the prediction equations may be a result of multicollinearity among the explanatory variables.

Introduction

Background

Many studies have examined the relative effect of multiple factors on mathematics achievement outcomes (e.g., Walberg, 1984). Most of these studies have investigated the relationship between factors and math achievement outcomes using raw or standardized achievement scores via multiple linear regression or analysis of variance techniques. When the raw scores of the response variable (i.e. math achievement) is normally distributed with respect to the predictor variable(s), and when assumptions of linearity and homoscedasticity are tenable, multiple regression and/or analysis of variance techniques may be applied. Unfortunately, many of the assumptions associated with multiple regression or analysis of variance are not satisfied by the variables used in social science research. Specifically, the assumption that the conditional distribution of the response variable is normal for each of the predictor variables is very often violated. In particular, when the response variable is measured as an ordinal variable, the assumption of the normality of the conditional distribution of the response on the predictors is not reasonable. Furthermore, when the response variable has a finite number of categories, estimated scores can assume impossible values if inappropriate regression procedures are utilized.

Unlike raw or standardized scores, proficiency scores or levels are not continuous variables. As part of the National Education Longitudinal Study of 1988, participants took cognitive tests in various academic areas, including mathematics. Raw scores as well as proficiency levels were determined based on the number of items answered correctly on the cognitive subject tests. The proficiency scores however provide a means

of distinguishing total scores and score gains, as measured by overall Item Response Theory – estimated number correct scores and norm-referenced t-scores, from criterion-referenced measurements of specific skills. At points along the score scale of the cognitive tests, four-item clusters of test questions having similar content area and difficulty were identified. A student was assumed to have mastered a particular level of proficiency if at least three of these items were answered correctly, and to have failed at that level if two or more items were wrong. Clusters of items provide a more reliable measure of proficiency than do single items because of the possibility of guessing on multiple-choice tests (U.S. Department of Education, 1994).

Purpose of the Study

The purpose of the current study is to determine the effect of various factors on mathematics achievement. The main focus of the current research is to ascertain whether gender and race are significant predictors of the highest level of math proficiency once other factors are introduced into the prediction model. The study applies logistic regression procedures to determine the effect of gender, race, parent's education, post-secondary education plans, advanced math course enrollment, socio-economic status, grades in math courses, amount of homework, school type, self-concept, and locus of control on the cumulative probabilities of overall proficiency and the probability of proficiency at the highest possible level. The study also analyses the strength of association between these factors and math proficiency using chi-squared tests.

Study

Participants

All of the participants in the present study were eighth grade students who took part in the base year wave of data collection for the National Education Longitudinal Study of 1988 (NELS: 88). The base year of the NELS: 88 "represents the first stage of a major longitudinal effort designed to provide trend data about critical transitions experienced by students as they leave elementary school and progress through high school and into college or their careers" (National Center for Education Statistics, 1989, p. 19).

Data Collection

For the base-year component of the NELS: 88, a two-stage stratified probability sample was used to select a nationally representative sample of schools and students. For the first stage, schools constituted the primary sampling unit. A pool of 1.032 schools was selected through stratified sampling with probability of selection proportional to eighth-grade size and with over sampling of private schools. A pool of 1,032 replacement schools was selected by the same method. Of the 1,032 initial selections, 30 were considered ineligible. Of the 1,002 eligible schools, 698 participated. An additional 359 schools (supplied by alternative selections from the replacement pool) also participated, for a total sample of 1,057 cooperating schools, of which 1,052 schools (815 public schools and 237 private schools) contributed usable student data. In addition, to the selection process described above, over-sampling of schools with very large percentages of African-American or Hispanic students or both was conducted based on information provided to the National Opinion Research Center (NORC), a subcontractor

for the NELS: 88 base-year study, and by the Office of Civil Rights (ORC) and other sources.

The second stage of the base-year selection process produced a random selection of 26,435 students among the sampled schools, resulting in participation by 24,323 eighth-grade students (an average of 23 students per school). For the current study, the sample was reduced to approximately 10,000 after eliminating those who had incomplete transcript information or either non-response or multiple responses for items used in the current research.

Using random sampling procedures, a sub-sample of approximately 450 students was selected for the present study. By using a random number seed other than 0, the same sample group was included in each of the analyses. The relative frequencies for the item-responses among the sub-sample were very similar to the frequencies obtained from the full sample.

The data for the present study was acquired from the Public Use version of the CD-ROM Electronic Codebook System of the National Education Research Longitudinal Study: 1988-1994 (1996). The data files on this CD-ROM included results from the base-year through third follow-up of the NELS: 88.

Instrument

The base-year study of the NELS: 88 included a self-administered questionnaire for gathering information about background variables and a range of other topics including school work, aspirations, and social relationships (Peng & others, 1995). The students also completed a series of cognitive tests developed by the Educational Testing Service (ETS). The cognitive test battery included a multiple choice mathematics test,

which consisted of quantitative comparisons and other questions assessing mathematical knowledge. The student questionnaire asked students about such topics as academic achievement; student perceptions of their curriculum and school, family structure and environment; social relations; and aspirations, attitudes, and values, particularly as they relate to high school and occupational or post-secondary educational plans (U.S. Department of Education, 1994).

Procedure

The present study used logistic regression procedures to (1) compare the predictive power of gender and race alone to the predictive power of the full model (i.e., including these variables as well as other factors) relative to the highest level of math proficiency and (2) investigate the relationship between several background variables and overall level of math proficiency. The first logistic regression analyses included two separate models. The first model included racial/ethnic categories and gender as predictors and the second model included school type, enrollment in advanced or accelerated math course work, math grades between 6^{th} and 8^{th} grade, post-secondary education plans, parent's highest level of education, number of hours spent on math homework per week, overall reading proficiency, self-concept, locus of control, socio-economic status, gender, and race/ethnicity with the dichotomously coded variable representing math proficiency at the highest level as the response variable for both models. The second logistic regression analysis produced a cumulative logit model which included all the predictors named in the previous analysis and level of math proficiency measured as either below level 1, level 1, level 2, or level 3 proficiency as the response variable. The proficiency levels are described below. In addition to the logistic

regression analyses, the study also examined the bivariate associations between each of the predictor variables and math proficiency using correlations and chi-squared tests.

Variables used in the Study

Overall reading proficiency was the students' level of mastery of certain skills on the cognitive test of reading ability. The proficiency scores provide a means of distinguishing total scores and score gains, as measured by overall IRT-Estimated Number Right scores and the norm-referenced t-scores, from criterion-referenced measurements of specific skills. At several points along the score scale of the reading test, four-item clusters of test questions having similar content and difficulty were identified. A student was assumed to have mastered a particular level of proficiency if at least three of the four items in the cluster were answered correctly, and to have failed at this level if two or more items were wrong. Clusters of items provide a more reliable test of proficiency than do single items because of the possibility of guessing in a multiple-choice test. Additionally, the proficiency levels followed a Gutman model, that is, a student passing at a particular skill level was expected to have mastered all lower levels. Conversely, failure at a given level indicated non-mastery at higher levels (U.S. Department of Education, 1994). Scoring for reading proficiency was 1 = below level 1, 2 = level 1, but not level 2, and 3 = level 2. Higher scores indicate greater reading skills.

School type represented the attendance at a public, Catholic, private religious affiliated, or private non-religious affiliated school.

Self-concept was measured using the composite of items in multi-part question from the student questionnaire. These items were "I feel good about myself", "I feel I am a person of worth, the equal of other people", I am able to do things as well as most other

people", "On the whole, I am satisfied with myself", "I certainly feel useless at times", At times I think I am no good at all", and "I feel I do not have much to be proud of". Each of the items was standardized separately to a mean of 0 and standard deviation of 1. The composite represents the sum of the standardized scores. Some of the items had to be reverse coded so that lower scores corresponded to lower self-concept and higher scores corresponded to higher self-concept.

Locus of Control was also measured using a composite of items. These items were "I don't have enough control over the direction my life is taking", "In my life, good luck is more important than hard work for success", "Every time I try to get ahead, something or somebody stops me", "My plans hardly ever work out, so planning only makes me unhappy", "When I make plans, I am almost certain I can make them work", and "Chance and luck are very important for what happens in my life". The items were standardized and recoded so that lower scores corresponded to lower control.

Socio-economic status was constructed using the following items: father's education level, mother's education level, father's occupation, mother's occupation, and family income. The items were summed and then standardized to form the composite measure of SES. The other predicators were either derived from transcript data or the self-administered questionnaire.

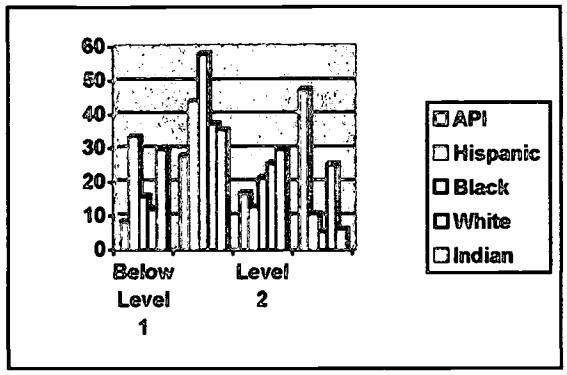
The dichotomously coded response variable represents whether or not the student exhibited math proficiency at the highest level. Students at the highest level can apply reasoning skills to solve multi-step problems. They can solve routine problems involving fractions and percents, recognize properties of basic geometric figures, and work with exponents and square roots. They can solve a variety of two-step problems using

variables, identify equivalent algebraic expressions, and solve linear equations and inequalities. They are also developing an understanding of functions and coordinate systems.

The other response variable represents a refinement of the previous response variable. In particular, math proficiency was partitioned into 4 exhaustive and mutually exclusive categories, below level 1, level 1, level 2, and level 3. Students at level 1 know some basic addition and subtraction facts, and most can add two-digit numbers without regrouping. They also recognize simple situations in which addition and subtraction apply. Students at level 2 know some basic multiplication and division facts, recognize relations among coins, can read information from charts and graphs, and use simple measurement instruments. They also have an understanding of the four basic operations. Additionally, they can apply whole number addition and subtraction skills to one-step word problems and are able to analyze simple logical relationships. Figure 1 shows the relative frequencies of the math proficiency levels according to race of the student for the sample and Figure 2 shows the relative frequencies of the proficiency levels according to gender.

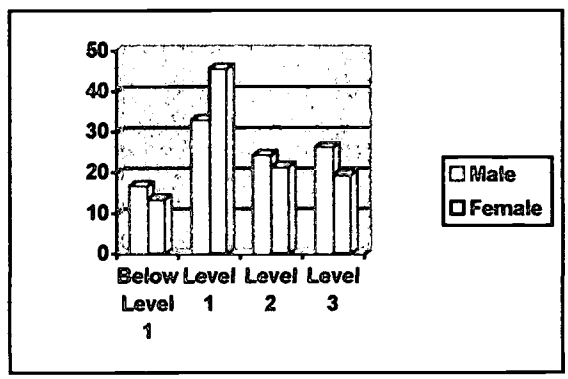
The relative frequencies of the responses for the categorical and ordinal variables were computed, while univariate statistics were used to analyze the distribution of the continuous variables.

Figure 1. Relative Frequencies of Math Proficiency Level by Race



Race	Relative Frequencies of Proficiency Level (%)			
	Below Level 1	Level 1	Level 2	Level 3
API	8.3	27.8	16.7	47.2
Hispanic	33.3	43.8	12.5	10.4
Black	15.8	57.9	21.1	5.3
White	12.0	37.2	25.5	25.2
Indian	29.4	35.3	29.4	5.9

Figure 2. Relative Frequencies of Math Proficiency Level by Gender



Gender	Relative Frequencies of Proficiency Level (%)			
	Below Level 1	Level 1	Level 2	Level 3
Male	16.7	32.9	24.3	26.2
Female	13.4	45.6	21.4	19.4

Results

A. Correlation and Chi-Square Analyses

Bivariate correlations were produced for several of the variables in the current study, including gender, reading proficiency, advanced math, grades, post-secondary education plans, locus of control, parent's education, self-concept, socio-economic status (SES), homework hours, and math proficiency.

The variables which were found to be correlated to math proficiency at the .05 significance level included reading proficiency ($r = .41$), advanced math ($r = .33$), grades ($r = .30$), post-secondary education plans ($r = .25$), locus of control ($r = .13$), parent's education ($r = .32$), SES ($r = .33$), and homework hours ($r = .22$). Additionally, several explanatory variables were also correlated with one another. In particular, parent's education was correlated with reading proficiency, advanced math, grades, post-secondary education plans, SES, and homework hours. Self-concept was correlated with gender, advanced math, grades, post-secondary education plans, locus of control, and SES. Gender was positively correlated to self-concept, indicating that males had higher self-concept than females.

Chi-square analyses were applied to determine the level of association between the discrete predictor variables and math proficiency. Preliminary analyses indicated that some of the cells or categories needed to be collapsed since some levels of variables had expected frequencies below 5. The results of these tests indicate that there were associations between math proficiency and reading proficiency ($\chi^2 = 64.42$, $p < .01$), advanced math ($\chi^2 = 42.18$, $p < .01$), grades ($\chi^2 = 42.95$, $p < .01$), post-secondary education plans ($\chi^2 = 25.76$, $p < .01$), parent's education ($\chi^2 = 49.58$, $p < .01$), homework

($\chi^2 = 26.10$, $p < .01$), school type ($\chi^2 = 36.69$, $p < .01$), and race ($\chi^2 = 26.70$, $p < .01$). The results of the preceding bivariate analyses suggest that most of the predictor variables are associated with math proficiency. Furthermore, the correlation analysis indicates that many of the predictor variables may be left out of the subsequent logit models because of their correlation with other variables in the equation.

B. Logit Model I: Math Proficiency on Gender and Race

Logistic regression analysis was conducted with racial/ethnic groups and gender as predictor variables. The variable Race was recoded for the present study. Four dummy variables were created, representing Asian/Pacific Islanders or not, Hispanic or not African American or not, and Native American or not, respectively. The White category was used as the reference.

This particular analysis produced the following prediction equation

$$\log\left(\frac{\pi}{1-\pi}\right) = -1.14 + 1.03X_1 - 1.01X_2 - 1.75X_3, \text{ where}$$

X_1 = Asian / Pacific Islander,

X_2 = Hispanic, and

X_3 = African - American.

The prediction equation indicates that the estimated odds ($e^{\beta_i\hat{}}, i = 1, 2, 3$) of math proficiency for Asian/Pacific Islanders equal 2.81 times the estimated odds for Whites. The estimated odds of proficiency for Hispanics are .37 times the odds for Whites. Finally, the estimated odds of proficiency for African Americans are .17 times the odds for Whites. These results show that the estimated likelihood of proficiency for Asian Americans is greater than that for Whites. Conversely, Whites are more likely to be proficient than either Hispanics or African Americans. Gender was not included in the final prediction model, indicating that this variable did not meet the .05 level of

significance. This suggests that there is no difference in the odds of math proficiency between males and females once race is controlled.

The global null hypothesis test statistics (-2 log L = 24.44, $p < .01$ and Score-statistic = 23.30, $p < .01$) indicated that at least one of the parameter estimates in the model was non-zero. The goodness-of-fit statistic was very small, but not significant, suggesting that the model fits the data well. But the small value for the generalized coefficient of determination ($R^2 = .05$) indicates that the variables in the prediction equation explain only 5% of the variance in math proficiency.

The measures of association show that 36% of the pairs are concordant and 10% are discordant, with 54% of the pairs tied. The gamma statistic was $\gamma = .55$, indicating moderate dependence between math proficiency and both gender and race. The Akaike Information Criterion and Schwartz Criterion for the current model were 446.71 and 422.49, respectively.

C. Logit Model II: Math Proficiency on Predictors of Math Achievement

Logistic regression procedures were used to determine the effect of gender, race, as well as parent's education, advanced math course enrollment, grades, post-secondary education plans, reading proficiency, school type, hours of math homework, locus of control, socio-economic status (SES), and self-concept on the probability of math proficiency at the highest level. The final logit regression model included reading proficiency, advanced math, socio-economic status, grades, homework hours, and gender. No additional predictors met the .05 significance level for entry into the model. Table 1 shows the parameter estimates, standard errors, and odds ratios for the variables in the prediction equation.

The prediction equation produced from this analysis was

$$\log\left(\frac{\pi}{1-\pi}\right) = -9.26 + 0.65X_1 + 1.52X_2 + 0.79X_3 + 0.001X_4 + 0.28X_5 + 1.60X_6, \text{ where}$$

X_1 = Gender,
X_2 = Advanced Math,
X_3 = Grades,
X_4 = SES,
X_5 = Homework, and
X_6 = Reading Proficiency.

This final logit model indicates other things being fixed, the probability of math proficiency increases with increased reading proficiency, advanced math course enrollment, SES, math grades, homework hours, and being male. The odds ratios ($e^{\beta_i\hat{}}, i = 1, 2, 3, 4, 5, 6$) for these variables were 4.97 for reading proficiency, 4.59 for advanced math, 2.22 for grades, 1.92 for gender (males versus females), 1.33 for homework hours, and slightly above 1.0 for SES. The Wald statistic was significant at the .01 significance level for advanced math, grades, SES, homework, and reading proficiency. The Wald statistic for gender was significant at the .05 significance level.

The global null hypothesis test statistics indicated that at least one variable had a non-zero regression parameter estimate (-2 log L = 141.68, Score-statistic=114.37, ps < .01). The Hosmer and Lemeshow test indicated that the model fit the data well (χ^2 = 13.89, p = .08). The general coefficient of determination for this model (R^2 = .34) shows that 34% of the variance in the log odds for math proficiency is accounted for by the predictor variables.

Furthermore, a comparison of the Akaike Information Criterion (AIC = 264.72) and the Schwartz Criterion (SC = 291.65) for the current and former models indicate that

the predictive accuracy of the full model is much greater than the model including only race and gender as predictors.

The Receiver Operating Characteristic Curve (ROC), plotting sensitivity against 1-specificity, indicated that the current logit model had high predictive accuracy. The classification table indicates that the cutoff probability level for which sensitivity and specificity are closest to 1.0 is between .1 and .2, showing that the ROC rises very quickly.

The analysis of the diagnostics indicated that nine observations had either deviation residual or Pearson residual values greater than 2. Twenty-nine observations had hat matrix diagonal values greater than three times the ratio of the number of predictors to sample size (e.g., 3*p/n = .036). However, no observation had both residual value and hat value greater than the suggested threshold for outlier status. Hence, there were essentially no ill-fitting observations in the current sample. It should also be noted that gender was significant in the current model, but not in the previous model. This result suggests that one or more of the predictor variables in the current model may be related to gender.

A follow-up logistic regression analysis including gender, but excluding reading proficiency in the equation indicated that gender was no longer a significant predictor of the odds of math proficiency once reading proficiency level was removed. This unlikely result may be due to the fact that reading proficiency is "suppressing" or controlling variance it shares with gender, but not with math proficiency, when it is included in the regression equation. Indeed, results of the correlation analyses indicated that reading proficiency was negatively related to gender (females had slightly higher reading

proficiency scores that males). Thus, it appears that the relationship between gender and math proficiency is "purified" in the presence of reading proficiency.

Table 1. Maximum Likelihood Estimates for Significant Predictors: Logit Model II

Variable	*Parameter Estimate*	*Standard Error*	*Odds Ratio*
Gender	.65	.32	1.92*
Advanced Math	1.52	.33	4.59**
Grades	.79	.22	2.21**
Socio-economic Status	.001	.0002	1.00**
Homework	.28	.11	1.33**
Reading Proficiency	1.60	.30	4.97**

** $p < .01$.
* $p < .05$.

Several predictors were not included in the final logit model, including the four categories of race, the three categories of school type, post-secondary education plans, parent's education level, locus of control, and self-concept. The absence of these variables suggests possible evidence of multicollinearity between some of the predictor variables.

D. Cumulative Logit Model: Math Proficiency on Predictors of Math Achievement

The second logistic regression analysis, using the four-level response variable, indicated that only three variables were associated with overall math proficiency, with other factors being held constant. Results of the current analysis showed that private non-religious school attendance (Wald $\chi^2 = 7.68$, $p < .01$), advanced math (Wald $\chi^2 = 19.13$, $p < .01$), and homework (Wald $\chi^2 = 5.49$, $p < .05$), were related to increased math proficiency. Negative values for each of the parameter estimates indicate that attendance at private non-religious schools, advanced math enrollment, and increased amount of homework are related to higher math proficiency levels. In particular, the odds of a

student enrolled in a private non-religious school having a higher proficiency level in math are 5 (i.e., 1/.2) times the odds for a student attending public school. The odds of a student who was enrolled in an advanced math course to have a higher proficiency level are 2.56 (1/.39) times a student who was not. The odds of higher math proficiency increase by a factor of 1.19 (1/.84) for each level increase in the homework variable.

The various model fitting statistics (-2 log L = 63.29 and Score = 53.36, ps < .01) indicate that at least one of the variables had a non-zero parameter estimate. Concordance is 66.5% and discordance is 33.1%, indicating that the cumulative model predicts the odds of proficiency quite well. Table 2 illustrates the parameter estimates, standard errors, and odds ratios for all of the predictor variables in the current logistic procedure.

Table 2. Maximum Likelihood Estimates for All Predictor Variables: Cumulative Logit Model

Variable	*Parameter Estimate*	*Standard Error*	*Odds Ratio*
Catholic School	.04	.36	1.04
Private Non-Religious	-1.61	.58	.20
Private Religious	-.11	.54	.89**
Gender	-.21	.21	.81
Advanced Math	-.95	.22	.39**
API	-.47	.39	.63
Hispanic	-.50	.34	.61
Black	.28	.38	1.32
Indian	.74	.62	2.10
Grades	.02	.11	1.02
Post-Secondary Education Plans	.15	.10	1.17
Locus of Control	.09	.22	1.09
Self-Concept	.01	.19	1.01
Socio-economic Status	-.0002	.0003	1.00
Parent's Education	-.06	.15	.94
Homework	-.17	.07	.84*
Reading Proficiency	-.28	.17	.76

** p < .01.
* p < .05.

Discussion

The results of the logistic regression analyses suggest that several variables have an effect on the probability of greater proficiency in mathematics skills for the sample of eighth grade students. In particular, the results of the first analysis indicate that enrollment in advanced math courses, grades in math courses, amount of homework done during the week, reading proficiency level, and socio-economic status have a substantial impact on the probability of proficiency at all three levels. To a lesser degree, the analysis also suggests gender has an effect on the likelihood of proficiency at all three levels. It seems reasonable to assume that the ability to read at higher levels and advanced course work helps students to solve word problems. Grades in math courses indicate that the students have attained a certain level of proficiency in prior math classes. The effect of homework on proficiency suggests that more time on task and practice on math outside of school help students to develop an understanding of the concepts necessary to achieve at the highest level of proficiency.

The results indicate that there is a greater likelihood of males to perform at the highest level of proficiency than females. Although, when reading level is not controlled, the odds of females performing at the highest proficiency level are no different than males. This suggests that females who read at higher levels tend to have higher proficiency levels in mathematics.

The results of the second logistic regression analysis indicate that advanced math course enrollment and increased amounts of homework increase the odds of higher proficiency levels in mathematics. The results also suggest that student's enrolled at private, non-religious affiliated schools are more likely to achieve higher levels of math

proficiency than student's at public schools. There are likely several reasons why students at private schools have greater likelihood of proficiency than those at public schools. Some of the reasons may be socio-economic factors, teacher quality, smaller class sizes, and more individualized instruction (Ferguson, 1990; Walberg, 1984).

One of the more significant results of the analyses was that race had a significant impact on proficiency before other factors were controlled. But, once the other variables were entered into the model, the effect of race on the odds of math proficiency was substantially reduced. In particular, the preliminary logistic regression analysis indicated that Asian/Pacific Islanders and Whites were more likely to perform at the highest level of proficiency than Blacks, Hispanics, or Indians. But, upon entering the other factors into the model, the odds of Blacks, Hispanics, and Indians achieving at the highest proficiency level were the same as for Whites and Asian/Pacific Islanders. This result suggests that other factors being equal, under represented minorities are as likely as Whites or Asians to perform at the highest level of math proficiency. The goodness-of-fit statistics further suggest that race and gender may be sufficient predictors of math proficiency, but other variables should be included in the logit models to maximize the predictive accuracy of the model of math proficiency.

Conclusion

The current analyses suggest that various factors have an influence on the probability of mathematics proficiency level among students. In particular, reading level, advanced math courses, socio-economic status, grades, and homework all affect the likelihood of math proficiency. The effect of gender is also evident, but only when the level of reading is controlled. Moreover, other things being equal, race makes no apparent contribution to the probability of proficiency in mathematics.

Based on the goodness-of-fit statistics, the model used in the current study fits the data very well. In other words, the model predicts the probability of success (i.e., proficiency) with a high level of accuracy. However, the value of the overall coefficient of determination indicates that the proportional reduction in error was only 34%. This suggests that many predictor variables associated with math proficiency outcomes were not included in the final log-odds model. As suggested previously, this is likely due to the significant correlation between many of the predictor variables in the model. This phenomenon is quite common in social science research where many of the independent variables can be highly correlated with one another.

The output of procedures that were not included in the Appendix may be obtained from the author.

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